Executive Summary

Introduction

Under Section 303(d) of the Clean Water Act, states must identify waters for which effluent limitations, as required by Section 301, are not sufficient to implement established water quality standards. EPA, Oregon and Washington have identified portions of the main stem of the Columbia River from the International Border (Columbia River Mile 745.0) to the mouth at Astoria, Oregon, and the Snake River from its confluence with the Salmon River at river mile 188 to its confluence with the Columbia River as water quality limited for temperature pursuant to Section 303(d) of the Clean Water Act. Section 303(d) also requires the development of a Total Maximum Daily Load (TMDL) for water bodies included on the 303(d) list. The scope of this Problem Assessment is water temperature in the main stem segments of the Columbia River from the Canadian Border to the Pacific Ocean and the Snake River from its confluence with the Salmon River to its confluence with the Columbia River. This information will be utilized as the framework for the subsequent TMDL.

This Problem Assessment briefly describes the Columbia Basin: geography, climate, hydrology, human development, salmon stocks and Indian Tribes. This is followed by an evaluation of water temperature problems in the Columbia and Snake Rivers, utilizing existing data and the results of temperature modeling. Finally, the effects of elevated temperatures on salmon resources are evaluated.

Temperature Assessment

The water quality standards applicable to most of the river system under consideration in this TMDL restrict temperature increases over specified temperature criteria due to human activities. For example, the Washington standard for the lower Columbia River is:

> *"Temperature shall not exceed 20 C due to human activities. When natural conditions exceed 20 C no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3 C..."*

Evaluation of existing water temperature against this standard requires knowledge or estimates of natural water temperature before the river was impounded.

This temperature assessment relies on existing temperature data and mathematical modeling of the temperature to describe the existing temperature regime of the impounded river and the natural temperature regime of the un-impounded or free flowing river. Both the temperature observations and the temperature simulations provide estimates of water temperature. Since there are information gaps and uncertainties associated with both the observations and the simulations both are used to gain an understanding of the free flowing and impounded temperature regimes and the relative importance of dams, point sources and tributaries in altering the natural regime of the rivers.

There is a considerable record of temperature data from the Columbia and Snake Rivers. McKenzie and Laenen (1998) assembled temperature data from 84 stations along the two rivers within the study area of this TMDL. However, the extensive data base from along the rivers must be used with caution. Little, if any of the data were collected with the express objective of evaluating temperature in the river. Few of the sampling sites have quality assurance objectives or followed quality control plans. Temperature measured at the same time at one dam can vary quite a bit depending on whether it was measured in the fore bay, the tail race or the scroll case. In using these data it is important to compare like stations along the river (e.g. scroll case to scroll case, fore bay to fore bay) and to use long records or repetitive examples when drawing general conclusions about temperature trends.

The temperature model was developed to augment the understanding of temperature in the river derived from analysis of the data record.

There is a good deal of information available for development of the temperature model. For example there are 30 years of continuous weather, flow and water temperature data. However, there are also modeling challenges that cause uncertainty in the modeling results. For example there is little information on temperature in the free flowing river to compare with simulated temperatures. Therefore, the problem assessment relies heavily on both data analysis and modeling analysis.

The analysis in the Problem Assessment provides the following information about the natural and existing temperature regimes of the river:

- The temperatures of the Columbia and Snake rivers frequently exceed state and tribal water quality criteria for temperature during the summer months throughout the area covered by this TMDL.

- The water temperatures of the rivers before construction of the dams could get quite warm, at times probably exceeding the 20 °C temperature criteria of Oregon and Washington on the lower Columbia River.

- However, these warm temperatures were much less frequent without the dams in place. Temperature observations show that the frequency of exceedance at Bonneville Dam of 20 °C increased from about 3% when Bonneville was the only dam on the lower river to 13% with all the dams in place.

- The dams appear to be the major cause of warming of the temperature regimes of the rivers. Model simulations using the existing temperatures of tributaries and holding tributary temperatures to 16 °C revealed little difference in the frequency of excursion of 20 °C.

- Global warming or climate change may play a small role in warming the temperature regime of the Columbia River to date. The Frazer River, with no dams, shows an increasing trend in average summer time temperature of 0.012 °C/year since 1941, 0.022 °C/year since 1953.

- The average water temperatures of the free flowing river exhibited greater diurnal fluctuations than the impounded river.

- The free flowing river average water temperature fluctuated in response to meteorology more than the impounded river. Cooling weather patterns tended to cool the free flowing river but have little effect on the average temperature of the impounded river.

- The free flowing river water temperatures cooled more quickly in the late summer and fall.

- Alluvial flood plains scattered along the rivers moderated water temperatures, at least locally, and provided cool water refugia along the length of the rivers.

- The existing river can experience temperature gradients in the reservoirs in which the shallow waters are warmer.

- Fish ladders, which provide the only route of passage for adult salmon around the dams, can become warmer than the surrounding river water.